REMARKS

Applicants respectfully request reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow. Claims 24 and 25 are amended.

This amendment changes claims in this application. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier. Claims 1, 3-10, 12, 14-18 and 20-25 remain pending in this application.

Rejections under 35 U.S.C. § 103

Claims 1, 3-10, 12, 14-18 and 20-23 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,693,203 to Ohhashi et al. (hereafter "Ohhashi") in view of applicants' alleged admission in the Rule 132 declaration filed on April 12, 2004. Claims 24-25 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Ohhashi in view of acknowledged prior art on page 2, lines 1-24 (hereafter "the APA"). Applicants respectfully traverse these rejections for at least the following reasons.

As an initial matter, applicants note that the Examiner appears to have changed his position regarding the existence of inevitable impurities of Ta and oxygen in a Nb sputtering target. The Examiner appears to recognize that some amount of Ta and oxygen must inevitably exist in a Nb sputtering target. The Examiner no longer takes the position that it would have been obvious (or possible) to reduce to zero the amount of Ta and oxygen in the Nb sputtering target of Ohhashi.

Claims 1 and 18

Claims 1 and 18 are each directed to a high purity Nb sputtering target. Claim 1 recites an amount of Ta less than 3000 ppm and a Ta content dispersion within 30%, while claim 18 recites an amount of oxygen less than 200 ppm and an oxygen content dispersion within 80%. Ohhashi fails to suggest a Nb sputtering target with the Ta amount or dispersion

of claim 1, the oxygen amount or dispersion of claim 18, or the advantages of such a sputtering target in forming an interconnection film with low resistivity.

Ohhashi discloses a sputtering target. The sputtering target is of a material selected from the group of W, Mo, Ti, Ta, Zr and Nb, the target having uniform microstructure with crystal grain sizes of no more than 350 μm (col. 6, lines 32-43).

Ohhashi, however, fails to suggest a Nb sputtering target with a Ta amount and content dispersion as recited in claim 1, or oxygen amount and content dispersion as recited in claim 18. The Office Action relies on Applicants Rule 132 declaration for the proposition that Ta and oxygen are inevitable impurities in a Nb sputtering target, and thus any Nb sputtering target of Ohhashi would inherently possess Ta and oxygen as inevitable impurities. Applicants do not quarrel with the proposition that any Nb sputtering target of Ohhashi would contain inevitable impurities such as Ta and oxygen. Applicants submit, however, that Ohhashi recognizes neither the importance of reducing the Ta and oxygen impurities to the level recited in claims 1 and 18, nor the recited dispersion levels of these claims. Ohhashi fails to suggest reducing the Ta and oxygen to the recited levels in claims 1 and 18, respectively.

Moreover, Ohhashi fails to suggest any dispersion levels of Ta and oxygen in a Nb sputtering target, much less the levels recited in claims 1 and 18, respectively. With respect to the dispersion levels of Ta and oxygen, the Office Action states on page 3:

> Since Ta and O are inevitable impurities, their dispersion would be uniform in Nb sputtering target. Thus, the dispersion % of said O and Ta is zero.

Applicants respectfully disagree that merely because Ta and oxygen may be inevitable impurities, they would be uniformly dispersed throughout a Nb sputtering target, or have a dispersion % in the range recited in the claims. The mere fact that a Nb sputtering target contains impurities would not require that the impurity be dispersed uniformly. In other words, it is <u>not inherent</u> that if a Nb sputtering target has impurities of Ta and oxygen, those impurities are dispersed uniformly throughout the target.

As an example that proves this lack of inherency, applicants point to the present specification, which provides numerous examples of a Nb sputtering target having Ta and oxygen with non-zero dispersion. Thus, it is inaccurate to suggest that, merely because a Nb sputtering target has Ta and oxygen impurities, such impurities would be uniformly dispersed within the target.

Because Ta and oxygen impurities are not inherently uniformly dispersed throughout a Nb sputtering target, the dispersion (%) (as defined in the claims) of these impurities is not necessarily zero. The claims define dispersion (%) as follows: dispersion (%) = {(maximum value - minimum value) / (maximum value + minimum value)} X 100. The "dispersion (%)" as expressly defined in the claims is a measure of the fluctuation of the parameter in question, such as oxygen or Ta concentration. When an impurity is not uniformly dispersed, and its concentration fluctuates, its dispersion (%) is not zero.

With respect to the recited dispersion in the claims, the Office Action states on page 3:

> With respect to the dispersion % expression, that it is well settled that there is no invention in the discovery of a general formula that covers a composition described in the prior art.

Applicants have no quarrel with the general proposition that a recited formula in a composition claim does not make that claim patentable if any composition covered by that claim is described in the prior art. In the present case, however, Ohhashi's sputtering target may contain amounts of Ta and/or oxygen that are above the upper limits of claims 1 and 18, and the dispersion values are incapable of being known. Thus, the sputtering targets as claimed in claims 1 and 18, respectively, with the recited Ta and oxygen amounts and dispersion, are not described in Ohhashi. That is, claims, 1 and 18 do not read on any sputtering targets that are either identically described or disclosed in Ohhashi, nor upon any such targets that are taught or suggested by Ohhashi.

The stated rejection appears to be based on an improper application of the obviousness standard of § 103, in particular, by improper reliance upon the alleged inherency of certain features that are admittedly not disclosed or taught in Ohhashi. The concept of inherency is antithetical to the principal of obviousness, i.e., that which is not disclosed or

taught (hidden subject matter) is the opposite of subject matter that would have been obvious (open) to the skilled person. Thus, even if inherent (which is not even the case in this instance), the hidden subject is not necessarily known, and that which is not known cannot be obvious. See MPEP § 2141.02 (Obviousness cannot be predicated on what is not known at the time an invention is made, even if the inherency is later established).

While Applicants could understand the principle of an anticipation rejection based on a prior art reference that inherently disclosed (i.e., identically disclosed) a composition falling within claims 1 and 18, Applicants submit that there can be no valid "obviousness" rejection based on a reference (such as Ohhashi) that discloses neither the problem to be solved nor the theory of its solution. Ohhashi simply lacks any requisite "teaching" of the presently claimed invention.

Moreover, Ohhashi fails to suggest the advantages of the invention as claimed, or to even recognize the parameters that are important in attaining these advantages. As a result of intensive studies, the inventors have determined important parameters in solving resistivity problems of Nb liner films for Al films. When forming a Nb film using a Nb sputtering target, inevitable impurities of Ta or oxygen increase the resistivity of the film due to the formation of Ta oxide (such as Ta_2O_5), or when Al is present, intermetallic compounds (such as Al_3Ta). Therefore, for example, when the Nb film is used as a liner material for an Al wiring film, it is desirable to decrease the Ta or oxygen content to decrease the resisitivity of the Nb film.

The present inventors have realized, however, that merely decreasing the Ta or oxygen content alone does not decrease the resistivity of the entire Nb film with reproducibility. This is so because when the dispersion of the Ta or oxygen content is large, compounds such as Ta_2O_5 and Al_3Ta may exist locally in the Nb film. The inventors have found that, in high purity Nb sputtering targets, the <u>dispersion</u> and content of Ta in the Nb target, and the <u>dispersion</u> and content of oxygen in the Nb target are important parameters. These parameters are implemented in the sputtering targets of independent claims 1 and 18, which recite, respectively, the content and <u>dispersion</u> of Ta, and the content and <u>dispersion</u> of oxygen which provide an improved Nb sputtering target. By suppressing the dispersion of Ta

or oxygen in the Nb target, while at the same time decreasing the content of Ta or oxygen in the Nb target, it becomes possible to decrease the resistivity of the entire Nb wiring film, such as a film formed as a liner for an Al wiring film, when that film is formed using the sputtering target.

The beneficial effect of suppressing the dispersion of Ta or oxygen in the Nb target to within the levels recited in claims 1 and 18 is demonstrated in the present specification. For example, as can be seen from Table 1 (page 21), interconnection films comprising a Nb film formed using a Nb target containing Ta of not more than 3000 ppm in the target (sample Nos. 1 to 4) exhibit a lower resistivity as compared to interconnection films comprising a Nb film formed using a Nb target containing more than 3000 ppm Ta (sample Nos. 5-6). However, although Nb target no. 3 has a lower Ta content as compared with Nb target no. 4, the dispersion of Ta in the Nb target no. 3 (greater than the recited 30%), is higher than that of Nb target no. 4 (within 5%). As a result, the interconnection film comprising a Nb film formed using Nb target no. 3 exhibits a <u>higher</u> resistivity as compared with that of a Nb film formed using Nb target no. 4.

Further, Table 3 (page 25) of the specification lists interconnection films comprising a Nb film formed using Nb targets no. 1-7 which have an oxygen content of not more than 200 ppm, and have a lower resistivity as compared with that of other interconnection films (sample Nos. 8-10) not having the recited oxygen content. However, the interconnection film comprising a Nb film formed using Nb target no. 1 having a dispersion of oxygen content of 82 %, exceeding the recited dispersion of 80 %, <u>while having the lowest oxygen content</u> of the target samples, <u>has a higher resistivity</u> for the interconnection film as compared with that of the other interconnection films (no. 2-7). In particular, as compared with the No. 2 Nb target having an oxygen content similar to the No. 1 target, it is clearly seen that the dispersion of oxygen content has a significant effect on the interconnection resistivity of Nb film. Ohhashi completely fails to recognize or teach this key relationship that is the basis for the present invention, and consequently the reference does not and cannot render the present invention "obvious".

Claim 10

Claim 10 is directed to a Nb sputtering target and recites parameters concerning the grain diameter size of a Nb target that allows for suppressed occurrence of dust when sputtering. Claim 10 recites an average grain diameter of 100μm or less, a grain diameter in the range of 0.1 to 10 times an average grain diameter, and a dispersion of the grain size ratio of adjacent grains within 30%.

As the result of extensive investigation of the occurrence of giant dust particles generated from Nb targets, and the relation between Nb grains constituting the target and the giant dust particles, applicants found that, when an average grain diameter is 100 μm or less, each grain has a diameter in the range of 0.1 to 10 times the average grain diameter, a grain size ratio of adjacent grains is in the range of 0.1 to 10, and a dispersion of the grain size ratio of adjacent grains in the target is within 30%, the occurrence of giant dust particles can be effectively suppressed.

Ohhashi discloses a sputtering target having uniform microstructure and crystal orientations with crystal grain sizes of no more than 350 μm. Ohhashi, however, fails to teach or suggest the features recited in claim 10, i.e., "each grain has a diameter in the range of 0.1 to 10 times the average grain diameter and a grain size ratio of adjacent grains is in the range 0.1 to 10". As described on page 14, lines 1 to 5 of the specification, "the grain size ratios between the adjacent grains are particularly important to be in the range of 0.1 to 10. However, when the total dispersion of grain diameter of the Nb grains is large, there are many grains different in sputtering rate to result in larger steps in sputtering between the adjacent grains." Thus claim 10 is patentable over Ohhashi for at least the above reasons.

The Office Action continues to assert that the claimed grain size (presumably of claim 10) is up to 1500 μm which is overlapped by grain sizes of Ohhashi. Applicants again submit that this statement, aside from being incorrect, misses the point that Ohhashi does not suggest an <u>average</u> grain size less than 100 μm, or the advantages thereof in preventing dust. The above statement is incorrect at least in that the largest grain size contemplated in claim 10 would be 100 μm x 10, or 1000 μm, not 1500 μm. More importantly, however, it is the <u>average</u> grain size as recited that provides advantages in reducing dust. Whether or not some of the larger grains (grains up to 1000 μm) fall within the scope of the grains in the Ohhashi

target is irrelevant. Neither does Ohhashi recognize that the average grain size is important in reducing dust, nor does Ohhashi disclose the specific average grain size recited in claim 10.

The Office Action also states on page 5 that the claimed grain size distribution is much broader than the grain sizes taught by Ohhashi. Applicants disagree. Ohhashi discloses crystal grain sizes no more than 350 μm, but fails to suggest an average grain size less than 100 μm.

The APA also fails to suggest the parameters as recited in claims 1, 10 and 18, and thus fails to cure the deficiencies of Ohhashi.

For at least the reasons given above, applicants respectfully submit that claims 1, 10 and 18 are patentable over Ohhashi and the APA. Independent claims 24 and 25 include the same Ta and oxygen parameter limitations of claims 1 and 18, respectively, and are thus patentable for at least the same reasons. All dependent claims depend from one of claims 1, 10, and 18, and are patentable for at least the same reasons, as well as for further patentable features recited therein.

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 19-0741.

Respectfully submitted,

Date January 6, 2005

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